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ABSTRACT

Research literature regarding the aptitude treatment interaction (ATI) model of research is reviewed, and arguments for and against the use of the model are described. The purpose of the model is to allow a combination of desired properties of experimental and correlational methods. It yields disordinal interactions when experimental situations are carefully planned, but may yield ordinal interactions when they are not. Situations in which the model might prove valuable are outlined, and recommendations are made for using the model in reading research. It is emphasized that (1) close attention must be paid to defining experimental manipulations, (2) familiarity with instructional and aptitudinal variables is necessary, and (3) careful analysis of theoretical models of learning before application of the model to a research situation should avoid negative results. Reading research studies in which the ATI model was used are described, and figures and references are included. (MS)

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Individual Difference Research and Learning by Reading

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Any discussion of learning by reading is immediately faced with the problem that not all learners can read. Indeed, elsewhere in this conference there are those who are attempting to wrestle with definitions of functional literacy. Ralph Tyler (1965) once estimated that one-fifth of American children do not achieve a level of functional literacy and in many areas roughly half of the sixth-grade population is reading at or below a second-grade level. Thus, we may, by exclusion, not be addressing ourselves to a large component of the learning audience when we discuss learning by reading. While one is tempted to suggest that current reading instruction is disasterously ineffective and attend to that problem, there is still a considerably larger population of learners who can read and who can benefit by the study of learning by reading. It is suggested here, however, that many problems associated with inadequate treatments that lead to non-reading may also be implied in instructional or experimental treatments built around reading ability. More specifically, instructional treatments which depend on learning by reading may be differentially effective with competent readers as a function of personalogical predispositions which interact with those treatments.

The theme of this paper is familiar. We must improve upon the research models available for studying learning by reading. Presently, there are just too many deficiencies in the literature. Nearly fifteen years ago

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Cronbach (1957) censured the educational and psychological communities for maintaining two distinct disciplines of empirical inquiry. Cronbach argued that while experimental and correlational psychologies have implicit advantages and disadvantages intrinsic to the methods used, a third alternative was available which combined the properties of both. Most recently, the model has become known as the aptitude treatment interaction (ATI) model. Despite Cronbach's reproval and 15 years of research, little ATI research has been conducted in education. Indeed, Bracht (1970) offers a discouraging conclusion that only a relatively small proportion of ATI research meets rigid statistical standards for a disordinal interaction. If the lack of ATI research in education is acute, the lack of ATI research in reading is deplorable.

Educational research has accepted, apparently without much question, that classical models of research in which random assignment of subjects to treatment assumedly controls for any interactive effects. Jensen (1967) has noted that the typical experimental design assumes that the Subjects X Treatments interaction serves as "error variance". If a significant proportion of the variance in that error term is stable across a given aptitude,[1] then we may have ignored what otherwise might be a significant proportion of accountable variance. An interaction is said to occur when the slope of a regression line of a predictor variable with a criterion measure under one experimental treatment in significantly different than the scope of a regression line of the same predictor and criterion variable under another,

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[1] Aptitude is used here in the same way as it is described by Cronbach and Snow (1969). "Any characteristic of the individual that increases (or impairs) his probability of success in a given treatment." (p. 7).

independent treatment. If the two lines intersect within the range of the aptitude measured, the interaction is said to be disordinal. If the lines are not statistically parallel, but would intersect at some point beyond the range of the measured variable then the interaction is said to be ordinal. In the case of both ordinal or disordinal interactions, the effect of the interaction is such that the effect of treatment variables can be minimized. This is particularly true if the aptitude and treatment variables produce a disordinal interaction. This is depicted in Figure 1 and Figure 2. Figure 1 shows the two types of interactions and a condition where no statistical interaction occurs; Figure 2 is an attempt to describe the cumulative effect of collapsing the treatments over the two aptitude measures. This was done by estimating the mean of those regression lines. In the case of the ordinal interaction, the two treatments might be viewed as statistically different under normal tests. However, the differences for those who scored low on our hypothetical aptitudinal measure are negligible. In contrast the differences of those who scored high on our hypothetical aptitudinal measure would be statistically significant. The comparison of treatment means under the disordinal case might lead an investigator to conclude that no significant differences were to be found as a function of the treatments. Since the treatments interact with the aptitude treatment effects simply cancelled themselves out. Assuming random assignment of subjects to treatments, the question arises as to what proportion of existing non-significant research might be a function of the treatments interacting with some non-measured aptitude variable. Simply stated, where human learners are acting as subjects it may be meaningless to collapse aptitude variance within a given treatment where aptitudes

systematically interact with treatment variables, main effect comparisons may be useless. Even in a fixed treatment design if we ask the question is one method better than another and then find a disordinal interaction with a second set of treatments, we are clearly asking the wrong question (Lubin, 1961).

While the above definition of interaction is the most commonly associated with research, Bracht (1970) has suggested that for purposes of ATI research, we should attend primarily to disordinal interactions. Further, in an attempt to protect against Type I error, Bracht suggests that to be considered disordinal, the interaction must be such that the differences at each end of the aptitude continuum be statistically different. (Tests to determine that difference are covered elsewhere.) Thus, an interaction previously considered disordinal due to the intersection of regression lines, might no longer be considered disordinal if the differences of the means at the ends of the aptitude continuum as a function of the two experimental treatments were in different directions, but, one of those differences failed to reach statistical significance, the interaction would be considered ordinal rather than disordinal. Such a demand as that placed by Bracht, imposes rather strong restrictions on the prospective ATI researcher.

While Bracht's conclusions are valid for ultimate decision making on the basis of the ATI model, the disordinal interaction in which both extremes of the aptitude continuum must meet the requirements of statistically significant differences may be too conservative at this time. Reading researchers should not be discouraged at early stages of reading research when ordinal interactions are found. Ordinal interactions may be of such a

type as to suggest long-range programs of research. Further, non-significant disordinal interactions (by Bracht's standard) should be considered for their heuristic value in the sense that they may be suggestive of future research which could precipitate a disordinal interaction. Nonetheless, Bracht's review of existing ATI literature should dampen some of the initial enthusiasm for entering into this type of endeavor. His review clearly suggests that the search for ATI is likely to be long and hard and filled with disappointment. The investigator who enters the laboratory with a hypothesis for a sure-fire ATI may find the initial study less conclusive than he would have imagined. The major difference between successful and unsuccessful ATI research is likely to be that the researcher who is successful selects instructional and aptitude measures that have a strong theoretical base and pursues the interaction of those two variables programmatically.

The question may arise then, are there any heuristic models which suggest areas of study under the rubric of ATI research. Cronbach (1967) and Salomon (1970) have offered different models of ATI research as they apply to instructional design. However, these models have limited facility for suggesting avenues of research. In general, it can be suggested that either two avenues are open to ATI hypotheses. First, the investigator may initiate ATI research through a careful analysis of a given aptitude. This is primarily the type of strategy that is typically used by individuals who are trying to establish a nomological net within which they define some aptitude measure. Using this model, some ingenuity is likely to have to be devoted to the development and construction of effective instructional or

experimental treatments which meet the demands of a given aptitude. In contrast, the investigator may institute ATI research through a careful analysis of a given treatment variable. The investigator might analyze the characteristics of each instructional treatment to determine which, if any, aptitudes are likely to be differentially effective. For example, given two experimental manipulations previously considered not statistically different, the investigator might be motivated to analyze the tasks to see if they are characteristics of the different learning tasks which might interact with different individual differences. In such a case, it may be necessary to define task specific aptitude measures.

The search for aptitude measures might be aided by model offered by Fleischman (1967) which suggests that during the early stages of acquisition, general intellectual aptitudes might account for the largest components of variance while task specific aptitudes increasingly dominate during later stages. The suggestion has been made by others that individual difference research is likely to demonstrate that task specific aptitude variables account for large components of variance. The ATI model for reading research would thus demand close attention to the definition of experimental manipulations with care to determine which individual differences might emerge as a function of the features of the experimental treatments. Research by this author in the area of short-term recall of visual and auditory presentation has been guided by such a model and has lead to a strong disordinal interaction.

In either of the above mentioned orientations it should be noted that the investigator is assumed to be familiar with both instructional and

aptitudinal variables and their potential for interacting. Trial and error ATI research should be avoided at all costs since it is likely to lead to further frustrations of the type reflected in Bracht's review. Valuable research time can be saved through the careful analysis of theoretical models of learning and cognition as they apply to learning by reading for possible generation of a priori ATI hypotheses.

Some rather tentative literature exists which is suggestive of further ATI research in the area of learning by reading. Newton James (1962) tested the hypothesis that learners would acquire more when materials were presented in a manner which was congruent with their perceived preferences than when the mode of presentation was incongruent with their preferences. James simply asked his subjects to declare whether they preferred a reading or lecture presentation or had no preference. Subjects were then presented with material in either the preferred or non-preferred fashion. He found a significant ($p < .05$) interaction for recall as a function of reported presentation preference and the actual mode of presentation. An examination of the data, kindly supplied by Professor James, reveals that the interaction was the ordinal. However, while overall recall favored conditions of reading, the magnitude of the difference in recall under lecture vs. reading presentation was greatest for those learners who defined reading as their preferred mode of reception. That is, learners who stated that they preferred to read learned more when they were asked to read than when the material was presented as a lecture. Interesting, however, was the fact that those learners who declared a preference for lecture also performed about equal under conditions of reading and lecture. However, they performed significantly

better under lecture conditions than did learners who indicated a reading preference. Thus, while Bracht's (1970) stringent requirements for ATI studies would eliminate the James study as a successful ATI study, the results are suggestive of a number of avenues available in research in the area of learning by reading. At the minimum the James study should be replicated using appropriate controls.

The concept of modality preferences is not new. Galton (1883), for example, suggested that individuals demonstrate clear conceptual preferences in modes of organizing information. Using a recognition task, Carlson (1937; Carlson & Carr, 1938) found stable tendencies across several trials for some learners to consistently attend to visual (featural) or vocal (articulatory) cues of verbal stimuli during encoding and recall. More recently this investigator (Ingersoll, 1971; Ingersoll & Di Vesta, in press) found a disordinal ATI as a function of modality preferences and mode of presentation under bisensory conditions. While that investigation studied short-term memory, Senf (1969) using a bisensory paradigm, has shown that some bisensory performance is related to reading disabilities. The value of suing such aptitudes in the investigation of treatments associated with learning from connected discourse has yet to be investigated.

Berliner (1971) has presented evidence to suggest that memory abilities interact with organizational strategies used during reception learning. Using lecture-type presentation Berliner imposed three experimental conditions: note-taking, paying attention and test-like events of the type described by Rothkopf (1966). Berliner found that short-term recall interacted with note-taking and test-like events such that subjects with

high short-term recall benefited under conditions of note-taking when compared to performance under conditions of test-like events. Subjects with low short-term recall, on the other hand, performed better under conditions of test-like events. Berliner, however, used the rather conservative Johnson-Neyman (cf., Cohen and Linn, 1971) technique and reduced his probability of achieving a significant disordinal interaction of the type which meets the stringent requirements suggested by Bracht (1970). While there are apparent problems with his criterion test, the Berliner study is suggestive of a number of avenues which might be pursued in learning by reading. Berliner suggests that the superiority of note-taking conditions for subjects with high short-term recall may be a function of the need to hold information in storage until it is transposed to an external form of storage. It is not clear, for example, whether similar relationships would hold under written presentation. Sanders (1970) has found some evidence to suggest that intellectual aptitudes interact with the placement and the type of adjunct question.

One is tempted to view much of mathemagenic research as similar to the model of epistemic behaviors suggested by Berlyne (1965). That is, information search behaviors of readers changes as a function of some external variable. Thus, the reading researcher might be encouraged to consider the implications of a recent dissertation by Clark (1970). Clark found a disordinal ATI in information search behaviors of high versus low dogmatics and internal versus external locus of controls under conditions of differing subjective response uncertainty. If parallels do exist between mathemagenics and epistemic behaviors, then one is likely to expect interactive effects

as a function of passage type, placement of adjunct question, information load, and cognitive styles of the readers.

To summarize, the intent of the ATI models is to provide a more adequate model of educational and psychological research. The model can be summarized as follows, given different experimental or instructional treatments administered to readers who vary systematically along a continuum of a certain aptitude, differential achievement or success will result. That is, differing effects will be generated as a function of the interaction of the two sources of variance. Thus, the ATI model reduces the importance of questions concerning the effects of either variable considered singly. Indeed, the magnitude of the interaction may be sufficiently strong to eliminate main effects. And, in such a case, the interaction is clearly the more interesting source of information. The value of the ATI model for the investigation of learning by reading has yet to be explored. Nonetheless, the area is filled with fruitful hypotheses that might be explored. Finally, to paraphrase Melton (1967) we must construct hypotheses about individual differences and learning by reading in accord with the processes and constructs of comtemporary learning theory.

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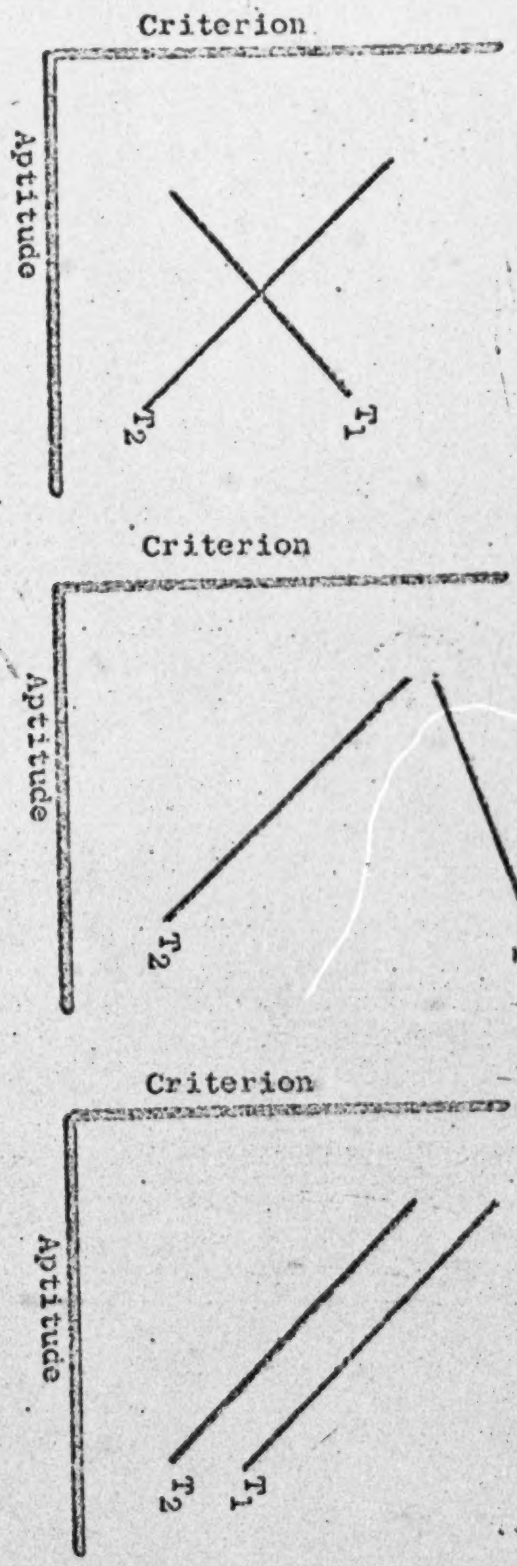

Figure 1: Descriptive examples of disordinal, ordinal, and no statistical interactions.

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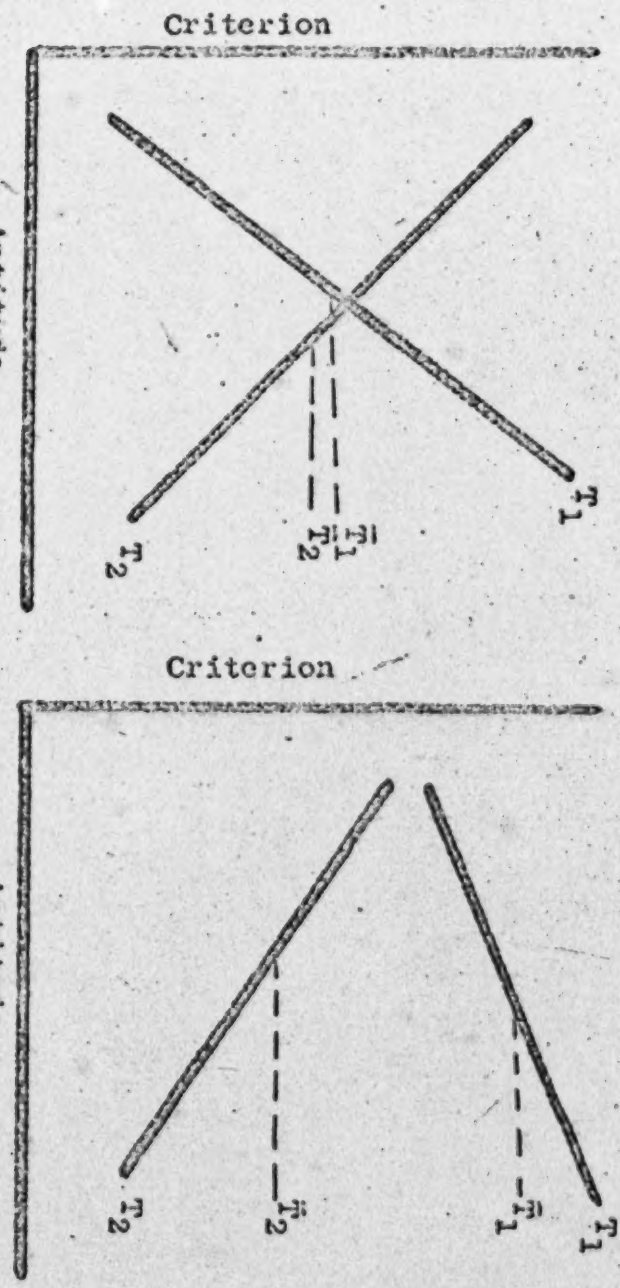

Figure 2: Projected treatment effects under disordinal and ordinal interactions.